European Partnership on Metrology
Call 2024 –Digital Transformation, Green Deal, Normative and Research Potential

Selected Research Topic number: **SRT-v14**
Version: 1.0

Title: Metrology for light pollution

Abstract

Light pollution comprises all adverse effects of artificial light in the night-time environment, an issue which new lighting technologies have significantly contributed to. Some European countries have taken action to mitigate the excess of artificial light at night, but regulations are difficult to comply with, in the absence of a standardised metrological basis for the measurement and assessment of light pollution and associated adverse effects. Proposals addressing this SRT should contribute to the establishment of a standardised, traceable, light pollution metrology by developing novel methods and metrics, and engaging with a wide range of stakeholders.

Keywords

Light pollution, obtrusive light, artificial light, environmental impact, sky glow, measurement metrics, metrology system, optical instrumentation

Background to the Metrological Challenges

Light pollution, mainly produced by outdoor lighting installations such as road lighting, floodlighting and landscape functional lighting, is a rapidly growing global environmental problem, fuelled not only by global urbanisation but also by rebound effects from energy-saving and cost-effective LED luminaires. While some European countries are taking action to address this issue, currently there are no agreed metrics and a variety of instruments are used to assess light pollution (e.g. imaging luminance measurement devices (ILMDs), commercial cameras with fisheye lenses, and remote sensing instrumentation).

The European Commission has identified improved methods for measuring, monitoring and assessing light pollution for nature conservation as an area of prioritised research (European Commission 2023). The International Astronomical Union (IAU) works relentlessly to protect observatory sites from pollution at all wavelengths of the electromagnetic spectrum. In parallel, the International Commission on Illumination (CIE) deals with problems of light pollution from lighting installations and its impact on the environment. While the problem is interdisciplinary, due to its complexity, it is still mainly addressed within specific disciplines. The use of different methods leads to missing uncertainty evaluation, validation and SI traceability and consequently prevents comparability of measurement results and creation of a unified monitoring network.

Currently, no agreed metrics exist for the measurement and assessment of light pollution and only limited guidelines and commonly accepted methods are available for the measurement of light pollution. In most cases, photometric quantities and correlated colour temperature have been used as commonly reported metrics. The currently revised technical report CIE 150:2017 is mainly focused on obtrusive light due to static, quasi-steady state and constant-colour lighting and its limitations. The adverse effects of light pollution on humans and ecosystems are assessed only in a limited range thus, without a standardised method.

A common metrology system for the measurement and assessment of light pollution will support international standardisation bodies CIE, CEN and IEC in the preparation of new standards. This will also help communities, as a unified traceable measuring system for measuring and assessing light pollution could help increase the awareness of light pollution globally. It could potentially lead lighting industry to develop and promote lighting products that minimise light pollution, and could also enable instrument manufacturers to develop new products. A standardised methodology would significantly improve measures to counteract light pollution impact on human and ecosystems.

EURAMET MSU,
Email: part.msu@euramet.org
Metpart.eu

European Partnership Co-funded by the European Union
METROLOGY PARTNERSHIP EURAMET

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The proposal shall focus on the traceable measurement and characterisation of light pollution in the environment.

The specific objectives are:

1. To establish and validate suitable metrics for the assessment of light pollution in the environment, taking into account wildlife and human related issues, and spectral, spatial, directional and temporal aspects. This should include the identification of the most relevant optical instrumentation and limitations of the measurements associated with the metrics and the instruments e.g., limit of detection, spectral resolution, dynamic range, and modulated light from outdoor lighting installations.
2. To define measurement methods and geometries for light pollution key applications, e.g., obtrusive light, sky glow, environmental assessment, upcoming laws and regulations, using ground, airborne and space observations.
3. To carry out an intercomparison of different optical instruments using the methods and geometries from Objective 2 for at least one essential light pollution measurand in the field of obtrusive lighting, to demonstrate traceability to the SI.
4. To set the minimum requirements for the processing and validation of long-term datasets considering local and temporal influence of environmental conditions when using distributed sensor networks. This should pave the way for a European monitoring network dedicated to short and long-term monitoring of light pollution.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (manufacturers of luminaires and instruments), standards developing organisations (CIE TC2-95, CIE TC4-58, CIE TC4-59, CIE TC4-61), and end users (e.g. environmental conservation bodies - Union for Conservation of Nature (IUCN), IAU, and the European Commission Directorate General Environment).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. Proposers shall give priority to work that meets documented needs, in particular those supporting the European Green Deal. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the Metrology Partnership projects 21NRM01 HiDyn and 22NRM05 MeLiDos, and how their proposal will build on those.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.8 M€ and has defined an upper limit of 3.5 M€ for this proposal.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the ’end user’ community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your proposal's results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Facilitate improved industrial capability, or improved quality of life for European citizens in terms of personal health, protection of the environment and the climate, or energy security,
- Transfer knowledge to the lighting sector.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects (JRPs)"

You should also detail how your approach to realising the objectives will further the aim of the Metrology Partnership to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Timescale

The project should be of up to 3 years duration.